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VERNACULAR CRAFT AND SCIENCE IN THE *EQUATORIE OF THE PLANETIS*

'The separation of liberal and mechanical arts manifested itself clearly in the literature of the [medieval] period', wrote Edgar Zilsel in 1942.[1] The coming together of scholars and craftsmen, according to the influential Zilsel thesis, caused the emergence of modern science in seventeenth-century Europe. Zilsel's explanation has been challenged, but his assumption that Latin scholarship and vernacular craftsmanship were different activities practised by different people in the late Middle Ages has remained intact.[2] It is in many cases true that there was a division between scientific and practical cultures, but that dichotomy could be blurred. The ways in which writers blended theoretical and practical material, exploiting the flexibility of the vernacular and moulding it to their needs, are exemplified by the *Equatorie of the Planetis*.

The *Equatorie of the Planetis* was, according to Larry D. Benson, 'the most important work to be proposed for inclusion in the [Chaucer] canon in recent years'.[3] This 1393 treatise occupies eight leaves of Cambridge, Peterhouse MS 75.I. It explains how to make and operate an equatorium, a device to compute the positions of the planets using raw data provided in the accompanying astronomical tables. The treatise was first put forward as a Chaucer holograph by Derek Price in 1952, and debates over its authorship ranged back and forth in the following half-century.[4] At least one leading scholar changed his mind on the issue; most Chaucerians remained sceptical; but no one was able to make a conclusive case against Chaucer's authorship.[5] The impasse remained until 2015, when Kari Anne Rand identified the manuscript's autograph hand. Twenty years earlier, Rand had convincingly argued that the *Equatorie* was an autograph draft, but that Chaucer's authorship could not be proved. Now she demonstrated palaeographically that the draft treatise was in the same hand as a pair of astronomical works donated to Tynemouth Priory *c*.1380. The donor had signed his copy: Dom. John Westwyk.[6]

Chaucer, then, can no longer be credibly claimed as the author of the *Equatorie*. This reattribution requires us to reassess much of what has been accepted about this important manuscript. In turn, it presents an opportunity to re-examine the categories we use to understand vernacular writing. This article

will argue that the practical didactic content and style of the *Equatorie* demand that it be understood not merely as a scientific work, but as a piece of craft writing. Such an understanding, alongside and in dialogue with other works of theoretical and practical knowledge, may in turn motivate us to re-examine the categories into which we place Middle English texts.

It was its use of the vernacular that arrested the attention of the *Equatorie*'s first editor, the physicist and historian of science Derek de Solla Price. He later wrote that, when leafing through the manuscript in the library of Peterhouse, Cambridge, he was struck by the fact that, despite the Latin incipit cited in the library catalogue, 'nearly every page was dated 1392 and written in Middle English instead of Latin … The conclusion was inescapable that this text must have had something to do with Chaucer.'[7] Exploring the connection, Price noted that Chaucer had promised that his *Treatise on the Astrolabe* (generally dated to *c*.1391) would consist of five parts; but that only the first two, on the parts and workings of the astrolabe, have come down to us.[8] Peterhouse MS 75.I contains 'diverse tables' which more or less match the prescription for Chaucer's proposed Part III, and the *Equatorie* itself, Price suggested, could have been planned as Part IV of the *Astrolabe*, which was to provide a 'theorike to declare the moevyng of the celestiall bodies with the causes'.[9] In thus categorizing a practical instruction manual as a 'theorike', Price not only challenged simple separations of theory and practice; he also made an important intervention in a debate within the still-nascent discipline of history of science about how the sciences and their instruments have helped humanity to conceptualize the cosmos and our place in it.[10] Thirty years later, in his 'Notes towards a philosophy of scientific instruments', he would argue that astrolabes, arising from 'a sheer love of machinery', were 'embodied explanation of the way that things worked … a sort of do-it-yourself creator kit for the animate and inanimate parts of Creation'. Such instruments, he wrote, had much more representative than practical value: 'the medieval terms for planetary simulations were *Theorik* and *Equatorie*; the brass devices went by the names we now use for abstract modelling.'[11] The *Equatorie of the Planetis* thus pushed at the boundaries demarcating theoretical and practical, didactic and observational.

However, the implications of the *Equatorie of the Planetis* for debates about the function and meaning of scientific texts in history has been obscured by a focus on its authorship. When it could be thought a companion to Chaucer's *Astrolabe*, its existence needed no further justification. Similarly, when it was believed to be written by the greatest promoter of Middle English, its language needed little further explanation, or was compared with that of the *Astrolabe* with the aim of learning more about Chaucer.[12] Now that we know the *Equatorie* is not by Chaucer we must re-examine how – and why – this instrument text was written in the vernacular. This will lead us to reassess its audience and purpose,

and perhaps in turn to reflect on how the assignment of such vernacular works to pre-defined genres colours our understanding of them.

Writing the sciences: Latin and the vernacular

Research in the half-century since the *Equatorie*'s discovery has shown that Price should not have been surprised to find an instrument treatise in the vernacular, even in a codex that begins in Latin. By the time the manuscript was composed in the early 1390s, writing in English was neither new nor unusual: the vernacular was used and accepted for many purposes in many different contexts.[13] A wealth of recent studies have shown how Latin and English could coexist within manuscripts and disciplines – as they do in MS 75.I – often in ways which demonstrate that code-mixing and code-switching were deliberate and effective discourse strategies.[14] They have also shown how the choice to use the vernacular (or not) could be contingent on subject matter.[15] Among scientific works, it has been observed that practical texts, especially those involving instruments, are disproportionately likely to be written in the vernacular; we can already see this trend in Anglo-Norman translations, but it seems to have heightened as Middle English developed.[16] This trend seems congruent with Michela Pereira's suggestion that vernacularization in alchemical works was fostered by their writers' 'experimental frame of mind'.[17] The *Equatorie* allows us to test and develop such claims, though we must bear in mind that circumstances will differ not only between scientific subjects but between European languages: the Castilian patronage of Alfonso X, for example, meant that Spain saw vernacular astronomy earlier than more Latinate Paris.[18] In addition, we must consider the challenges of defining 'vernacular'. Not only does the *Equatorie* manuscript contain a mixture of languages; individual words may be impossible to categorize, owing to the liminal linguistic status of much technical vocabulary at a time when English was developing rapidly to meet the needs of its users. Nevertheless, it seems clear that John Westwyk made a considered choice to use English, despite being a scholar with experience of writing in Latin on the subject of astronomical instruments.[19]

Previous accounts of Peterhouse MS 75.I have employed a wide variety of linguistic analyses, but those have mainly been directed towards the authorship debate, rather than elucidating the treatise's astronomical content and process of composition.[20] A new assessment can set the *Equatorie* alongside other vernacular works, as well as Latin texts, on comparable subjects.[21] Comparison with the *Astrolabe* remains useful, but – now that it no longer seems tenable to ascribe the *Equatorie of the Planetis* to Chaucer – for reasons other than simply learning about him. In the first place, as we shall see, his *Astrolabe* treatise had a significant influence on John Westwyk. More importantly, the similarities and differences in forms of expression between treatises on similar subjects can tell us

much about the characteristics of astronomical and craft writing in this period.[22] Although similarities between the *Equatorie* and *Astrolabe* are no longer seen as evidence of Chaucer's authorship, they could still indicate either his influence or two authors' use of common forms of expression. Here the *Equatorie* can act as an important counter to the myth of Chaucerian exceptionalism, in science as much as in literature.[23]

Apart from other Middle English writings, it is also instructive to make comparisons with scientific treatises in Latin, not only because the texts whose content is most comparable to that of the *Equatorie* were written in that language, but also because drawing contrasts with those texts should allow us to identify features that stem from its use of the vernacular. Yet comparisons between 'English' and 'Latin' texts are problematic: technical texts are rarely found entirely in English, but almost always contain words in Latin and sometimes other languages too.[24] More fundamentally, this was a period when English was rapidly developing as a language, changing its vocabulary, spelling, and syntax. This has a number of consequences for the linguistic study of a text like the *Equatorie*. In the first place, historians' attention is inevitably drawn to words whose first appearance within an English text comes in Peterhouse MS 75.I. If we are to assert that this is the first appearance of these words 'in English', it must be borne in mind that it is only their subsequent acceptance into the language that makes them English, rather than anything John Westwyk did. It is only this that distinguishes words like *eccentrik* and *withdraw* from *motus* and *aux*, which may now seem to the modern reader like loanwords used by the author for lack of a better alternative in English. Nonetheless, the choice to write in English did necessitate some linguistic innovation. The purpose of this article is to show how the subject matter and aims of the *Equatorie* influenced its style; in other words, the way that the vernacular was used, and sometimes moulded, for purposes that were explicitly practical and pedagogical. At the same time, this article will use the *Equatorie* to illustrate the characteristics of craft writing in Middle English.

Instrument craft

The word 'craft' was used to describe the contents of widely varying Middle English texts. Tracts ranging from 'The crafte of nombrynge' to 'The crafte of graffynge & plantynge' may seem to have little in common, and little to distinguish them from works entitled 'The art of …'[25] Nonetheless, although the word 'craft' was occasionally used to describe quadrivial sciences such as geometry, it normally had a firmly practical connotation of know-*how*. When John Gower divides knowledge into 'theorique', 'rethorique', and 'practique', it is under the last that he describes 'hem that ben artificiers / Whiche usen craftes and mestiers /

Whos art is cleped mechanique'.[26] The manual sense of 'craft' here could embrace a craft of use – in this sense, Chaucer's *Treatise on the Astrolabe* could be deemed a craft work since it is certainly a hands-on, 'how-to' guide to the instrument. Yet it is perhaps not truly 'mechanique' since it does not immerse its reader in the physical materials and manufacture of its subject. Chaucer is quite explicit about avoiding this subject: whilst most astrolabe treatises, including the one attributed to 'Massahalla' on which Chaucer's was based, began with a section on the construction of the instrument, Chaucer was able to omit that because, as he explained to Lewis, 'I have yoven the a suffisant astrolabie'.[27]

On the other hand, even those treatises such as pseudo-Massahalla that do have a 'Compositio' section preceding the 'Operatio' are often not truly practical, because although they are theoretically concerned with making, their explanation is largely geometrical. Thus the fact that the *Equatorie* treatise discusses the construction (and use) of an astronomical instrument does not in itself make it a piece of practical craft writing. Instrument treatises could be theoretical, especially where they were little more than explanations of how to reproduce Ptolemaic diagrams with movable parts.[28] The blurred boundaries between texts on instruments and instruments made (or drawn) in parchment or paper, between *theoricae* as theories and as geometrical or physical models, between instruments for illustration or for practice, help explain why, as Chaucer recognized, Latin was still the default choice of language for 'eny commune tretys of the astrelabie' – or other instrument.[29] Nevertheless, we should not be too pessimistic about the possibility of guessing the purposes of such treatises. They were practical when they dealt more with concrete measurements than geometrical ratios, and included apparatus that was more functional than abstract: fewer majuscule letters denoting points in a diagram; more nails.

This was certainly the case with the *Equatorie of the Planetis*. In an instruction manual that apparently combines original writing with material translated from Latin sources, its author fluently adapted his own scholarly astronomical knowledge to the level of a craftsman. Unlike many instrument treatises, in which sparse Euclidian descriptions of construction methods read like thought experiments, and which devote little attention to the practicalities of manufacture, the *Equatorie* is an intensely practically focused work.[30] John Westwyk not only listed appropriate (if somewhat ambitious) dimensions for the parts of his equatorium; he gave thought to how they could best be explained. For example, presumably realizing that his instruction to 'tak thanne a cercle of metal that be 2 enche of brede, and that the hole dyametre contene the forseide 72 enches or 6 fote', could refer either to a ring two inches wide, or a cylinder two inches high, he corrected it using a combination of erasure and correction (Figure 1) to read 'tak thanne a cercle of metal that be 2 enche of brede, and that the hole dyametre with in this cercle shal contene 68 enches or 5 fote and 8 enches',

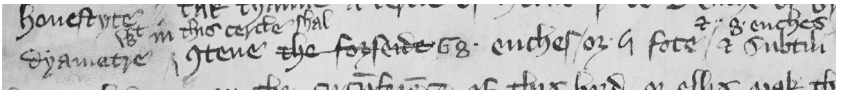

Figure 1: Corrections made by John Westwyk to his instructions. Peterhouse, Cambridge MS 75.I, fol. 71^{v}. Reproduced by permission of the Master and Fellows of Peterhouse, Cambridge.

thus making his meaning unambiguous.[31] In the same way, while other authors could refer to materials merely in passing, perhaps to help readers imagine their instrument more easily, Westwyk discusses wood, brass, and iron with the functional detail of a craftsman. His first instruction is to make a wooden disc 72 inches in diameter, and he shows his awareness of the potential difficulties of making and using such a large board by adding 'the whiche rownde bord for it shal nat werpe ne krooke, the egge of the circumference shal be bownde with a plate of yren in maner of a karte whel. This bord yif the likith may be vernissed or elles glewed with perchemyn for honestye.'[32] It is clear that he had already made the instrument himself at a smaller scale, as he laments that 'the centre defferent of mercurie hath but 24 holes as in myn instrment [*sic*]'; he had earlier suggested with practical flexibility that this circle of Mercury's mobile deferent centre should be pierced 'in 360 holes yif it be possible or in 180 or in 90 atte leste.'[33] The treatise is full of practical suggestions for a reader who will use its instructions to make the equatorium. There is a sense of passing on the lessons of bruising experience in the note 'I advise you not to write in the names of the Signs until you have checked that your common deferent centre is correctly and accurately placed on the Encloser of Signs on your equatorium.'[34] Westwyk even seems to anticipate and pre-empt his reader's mistakes, writing 'if you make this mistake, I shall teach you a remedy: knock your [common] deferent centre further in or further out until it stands exactly on the Encloser of Signs on the limb of your equatorium'.[35]

If such personally directed practical guidance is unusual in vernacular treatises; it is almost unheard-of in those in Latin. As an illustration, let us examine an item common to the majority of instrument treatises: the instruction to draw and divide a circle into four quadrants. Among the countless manuscripts in which that instruction appears, parallel Latin and English versions survive in an early fifteenth-century sundial text produced at the Augustinian Friary at Warrington (University of Aberdeen MS 123).[36] The translator of this text took the original instruction 'Describe circulum diametris eius ortogonaliter se intersecantibus supra centrum E. Et sint diametri AB & CD' and rendered it in English as follows: 'Fyrst make acercle with a cumpas of what quantyte ye lyk and devyde ye forsayd cercle eviyn in to 4 quarters wyth 2 lynys crossand tham self in the centre of the forsayd cercle and calle the ton lyne AB and the

tother lyne CD.'[37] This translation is noticeably more wordy than the original, noting that the size does not matter, while omitting to designate the centre of the circle as E.[38] But it maintains many of the same details, including the rest of the initial letters that were so popular in Latin treatises. The *Equatorie*, by contrast, adopts a quite different approach:

> tak thanne a cercle of metal that be 2 enche of brede … and subtili lat this cercle be nayle up on the circumference of this bord or ellis mak this cercle of glewed perchemyn. This cercle wole I clepe the lymbe of myn equatorie … this lymbe shaltow devyde in 4 quarters by 2 diametral lynes in maner of the lymbe of a comune astrelabye and lok thy croys be trewe proved by geometrical conclusioun.[39]

This is a practical rather than geometrical treatise: initial letters are eschewed in favour of examples of possible materials and explicit instructions about size. Technical terms are explained by analogy with objects already familiar to the reader. Here, as is most common in the treatise, the explicatory simile is to an astrolabe, but in other places homely objects like a cartwheel or needle are referenced. And we are given a useful tip to ensure that our two diameters are perpendicular. This is a model of practical prose.

Of course many of the features just noted stem at least in part from the author's personal style and purposes, so are independent of the language being used. Yet a more practical approach, and the use of craft terminology, was often easier, or even unavoidable, in the vernacular. For example, the Latin word 'ortogonaliter' (meaning 'at right angles') had no vernacular equivalent: the words 'orthogonal' and 'orthogonally' did not appear in English until the sixteenth century. This may explain why, in the passage quoted above, the Aberdeen translator replaced that one word with the explanation that the diameters should divide the circle evenly into four quarters.[40] A little later in the same treatise, the translator renders the instruction 'protrahe lineam … ortogonaliter' by 'drawe a lyne streght up and down'.[41] This circumlocution gives a less geometrical, more practical sense. Similarly, direct address to the reader, which helps Westwyk build a personal rapport with his audience, is facilitated by the explicit subject pronouns used in English. This personal quality could not be as clear in Latin since it is a null-subject language; the subject of the verb is only indicated by the conjugation of the verb.[42] The variety in Latin conjugation means that the subject is almost always identifiable, but nonetheless it does draw attention away from the actor. The use of the vernacular creates a more personal effect and, in particular, allows the author to emphasize his presence in the text.

It is clear that the different capacities of languages were closely aligned to their uses: words might not be coined unless there was a need for them. Although English was the most commonly spoken language throughout this period, its written uses were only gradually expanding, starting, as one might expect, with

those related to speech: the recording of what people said, for example in legal proceedings, and the dissemination of texts to be read aloud. Andrew Butcher has shown how the fifteenth-century estates account book of Canterbury Cathedral Priory, which generally followed a traditional format in Latin, used English in particular cultural contexts, particularly where subject-specific vocabulary was required; this included occupational names, building materials, and technical processes.[43] Anyone who has translated an extended piece of explicatory prose can confirm that there are many concepts that are easier to express in one language than another; translators are often forced either into clumsy circumlocutions or into leaving foreignisms that are as much transliteration as translation.[44] Perhaps the reason why Chaucer's prose in the *Astrolabe* 'flows artlessly through uncomplicated sentences', as Ralph Elliott thought, is that the vernacular was well suited to the author's expository purposes.[45] *The Equatorie of the Planetis* is marked by the deployment of a range of techniques which make it admirably clear – that its instructions can still be successfully followed today without the need for guesswork or peripheral research is an attribute rare among medieval treatises – but surely the choice of language was the first step in making it so.[46]

It is perhaps worth emphasizing that English was not in direct competition with Latin. Where English did compete with another language in this period, that language was mainly French; in the contexts where Latin ruled, it remained largely unchallenged.[47] Indeed in some contexts in the early fifteenth century, the use of Latin actually increased, as French fell out of favour while English did not yet command full acceptance.[48] But since the choice of language was heavily context-dependent, perhaps the most significant driver of a change in language use was a shift in the nature of those contexts: a change in the uses of writing. If we see the *Equatorie* as belonging to a new domain of instrument craft, the use of the vernacular does not result from rejection of Latin, but rather from the opening up of a new context for writing.[49] It clearly differed from other late medieval equatorium treatises, such as the much-copied design of Jean of Lignières or the complex *Albion* of Richard of Wallingford, in its practical and pedagogical focus.[50] While Jean's and Richard's treatises do describe certain practical steps involved in the construction of their instruments, such as selecting suitable materials or dividing a circle accurately, they still tend towards the theoretical, for example in the designation of points by letters of the alphabet, as used in geometrical and astronomical treatises since Euclid and Ptolemy. John Westwyk eschewed such symbolic letters in favour of practical tips for making holes, soldering metal, and filing brass, which were more easily explained in the vernacular. Nevertheless, he still used Latin where he felt it was appropriate, and drew on it as he coined new terminology in English. Thus the two languages interacted in ways that were much more complex than simple displacement of one by the other.

Pedagogy

It is all too easy to ascribe pedagogical intent to technical treatises, since a well-written technical text must by nature be somewhat didactic: it must have a clear meaning, invulnerable to alternative readings; important or unfamiliar terms must be defined, and so on.[51] But for a text to be truly pedagogical, rather than merely instructive, it should go beyond allowing the reader to reach a practical result (successfully producing an instrument, for example): it must have the further aim of giving the reader a profound understanding of what he is doing, enabling him to see why each part of the assemblage under construction takes the form that it does, and giving him the potential to make adjustments to the design. Although Chaucer's *Treatise on the Astrolabe* does not deal with the construction of an astrolabe (a task considerably more difficult than making an equatorium, despite the planetary instrument's greater theoretical complexity), it is still a practical treatise, and its pedagogical intent is undeniable. Likewise, when in its opening sentence the *Equatorie* informs the reader that 'the largere that thow makest this instrument, the largere ben thi devisiouns; the largere that ben tho devisiouns, in hem may ben mo smale fraccioun; and evere the mo of smale fraccioun, the ner the trowthe of thy conclusiouns', the didactic intent is made plain.[52] It is not enough for John Westwyk that his reader make the equatorium 72 inches in diameter: he wants him to understand why he should do so.

In any instructional treatise one would expect to find certain key terms defined near the beginning, and the *Equatorie* does not disappoint in this respect. The definition of terms is not unique either to treatises in English, nor to those that are didactic, but certain features of the way in which John Westwyk defines his terms are particularly noteworthy. First, not every term is defined: 'lymbe', 'aryn', and 'alhudda', for example, are, while some potentially problematic words like 'aux' (apogee) and 'motus' (usually referring to celestial longitude) are not. This suggests two possibilities: first, that Westwyk had a particular reader, or general type of reader, in mind, and set out to provide them with information that would be useful to them. Terms specific to the equatorium are generally defined, while those that have applications elsewhere in astronomy tend not to be, suggesting that the intended reader of this treatise had some knowledge of the subject but not of this particular instrument. The second possibility relates more directly to language, since the terms not defined seem to be those that are transliterated from Latin; this suggests that the reader might have been familiar with key astronomical terms in Latin but not in English.

A second noteworthy feature of the way that Westwyk defines his terms is that he does so explicitly, and often by identifying himself as the inventor of that term. Nine terms are explicitly defined in this way (see Appendix), using the

phrases 'wole I clepe', 'wole I calle', or 'is [or shal be] cleped'; a tenth is defined by direct reference to Chaucer: '[this] lyne is cleped in the tretis of the astrelabie the midnyht line' (Figure 2).[53] In contrast, Jean of Lignières never explicitly defines any terms; where a user might learn new words by studying his treatise, the definitions are implicit, as for example when the word 'limbus' is introduced by saying, 'ex utraque parte eleventur limbi aliquantulum ad modum matris astrolabii'.[54] Richard of Wallingford does define terms using the word 'dicitur', and sometimes disambiguates a certain part of his Albion instrument by saying that it 'est illa que …'[55] But, unlike John Westwyk, he never claims ownership of the term he is defining. Moreover, aside from the personal note that often appears in Westwyk's definitions, there is something of an oral quality to the words 'calle' and 'clepe'. He does not explain the 'name' (a word whose use as both noun and verb is recorded before the date of composition of the *Equatorie*) of any parts of his instrument; he always tells us how he *speaks* about it.

Thirdly, those terms that are defined using a phrase such as 'wole I calle' are always repeated immediately. This is the sign of a true teacher: one who knows that in order for a lesson to stick in the mind of his student, it must first be clear precisely what is being taught, and then it must be practised. So, for example, having instructed the reader to carefully nail a circle of metal on the outer two inches of the main disc of the instrument, Westwyk writes, 'this cercle wole I clepe the lymbe of myn equatorie'.[56] Then, in the remaining nineteen lines of that first page of the treatise, he repeats the word six more times: 'this lymbe', 'thy lymbe', 'the same lymbe', in such a way that the message cannot fail to stick in the mind of his reader. If he learnt this technique from Chaucer's deliberate 'superfluite of wordes', he certainly took it to heart; Chaucer's boast that 'now have I tolde the twyes' begins to look less impressive.[57]

This didactic spirit suffuses even the most purely practical parts of the *Equatorie*. The most obvious and attractive way in which this is achieved, heightening the text's readability, is Westwyk's personal touch. The word 'I' appears a full forty-eight times (and 'my' a further thirteen) in the fourteen pages of the treatise, constantly reminding the reader that the document he is reading is a proxy for the author and cannot be independent of him.[58] References to the reader are even more numerous: the word 'thy' appears 158 times[59] – surpassed only by 'and', 'in', 'of', and 'the' – and 'thow' another nineteen. The possessive adjective 'thy' is frequently used in situations where a user of modern English would more typically employ the definite article 'the': while in the early part of the treatise, where construction is discussed, it is most commonly attached to the reader's compass, later it is more likely to be attached to a part of the instrument such as the black or white thread, or even to a planet, as when a diagram is labelled 'thus lith thin instrument whan thow makest equacioun of thy mone'.[60] Some of these uses are perhaps just an alternative way of spelling the

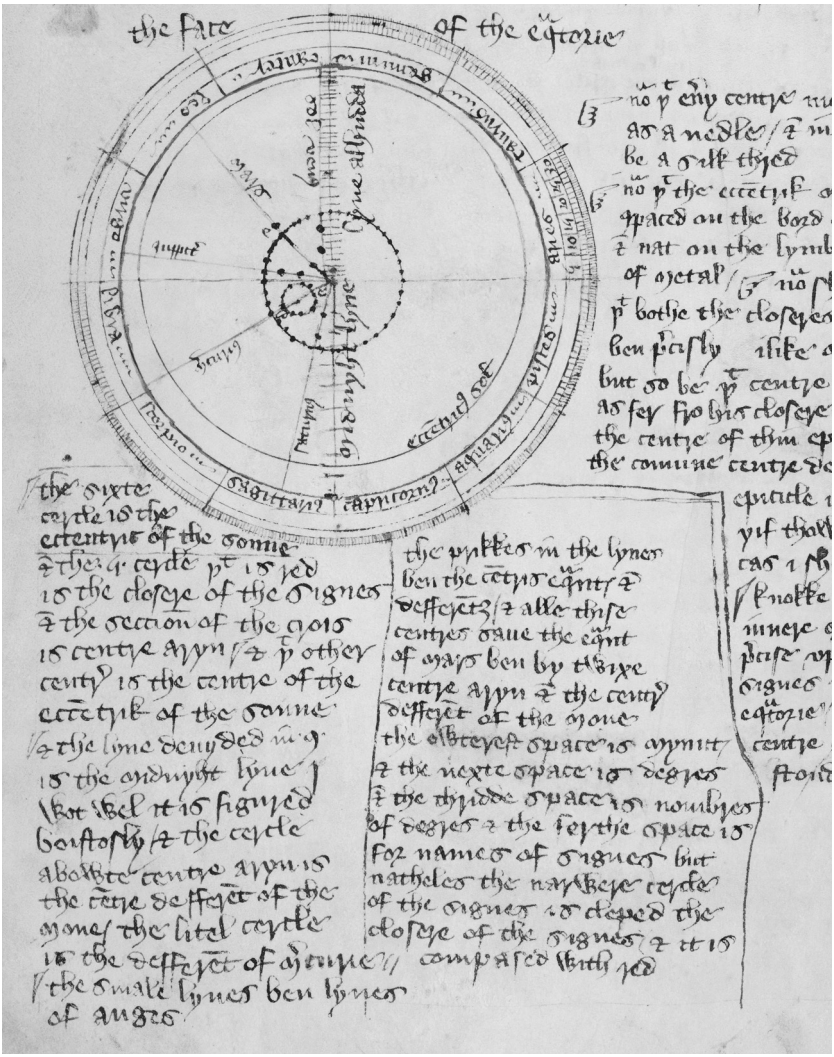

Figure 2: The face of the equatorie, showing 'lyne alhudda', 'midnyht lyne', and 'I wot wel it is figured boistosly'. Peterhouse MS 75.I, fol. 73^{v}. Reproduced by permission of the Master and Fellows of Peterhouse, Cambridge.

definite article, but Westwyk's use of 'my' for the same objects – 'my mone'; 'my thred' – suggests he is employing explicit personalization here. The same usage appears in the *Treatise on the Astrolabe*, where 'thy' refers both to parts of the instrument and to the object of the investigation, such as the Sun.[61] However, I know of no Latin treatises in which the possessive adjective is employed in this way. This may, in part, be because it would require the scribe to write an extra word (Latin has no definite article, though the demonstrative adjective 'ille' was in rare instances employed). But it also reveals the distinctive didactic approach that Westwyk used, perhaps influenced by his reading of Chaucer.

Whilst the above statistics do provide unquestionable data of the author's direct address to his audience, they nonetheless provide only a poor indication of the truly personal nature of the treatise. On every page Westwyk makes direct contact with his reader, in phrases such as 'I conseile the[e]', 'I seye considere', 'wyrk with Cauda as I tawhte the[e]'. The oral language in which these lessons are presented creates a clear image of a master coaching a pupil; in places the *Equatorie* could be the verbatim recording of an astronomy class.[62] There are moments of self-deprecation, as when Westwyk excuses a perfectly serviceable diagram of his instrument (Figure 2) with 'I wot wel it is figured boistosly.'[63] ('I know it is roughly drawn.') Self-deprecation was a popular literary conceit in Middle English texts at this time, but one does get the sense of an author and reader who enjoyed a genuine personal relationship, every bit as believable as that between Chaucer and his supposed son Lewis. And if the *Astrolabe* contains moral as well as astronomical lessons, as Seth Lerer believes – the reader and instrument user locating himself in the world geographically, politically, and theologically – this is at least as true of the *Equatorie*, pertaining as it does to an instrument whose potential astronomical and astrological functions, and concomitant impact on human behaviour, have clear moral implications for the person using it.[64]

Use of the instrument, as well as its construction, is also treated in frankly didactic terms in the *Equatorie of the Planetis*. As in the *Astrolabe* and other instrument texts, the author leads us step by step through a range of different functions. Here the *Equatorie* may be thought to move slightly away from the domain of craft writing, as Westwyk digresses from information that is relevant to the practical construction of the instrument, or to the goal of obtaining planetary longitudes, into material that has more in common with the geometrical astronomy of the *Theorica planetarum* tradition, as when he explains the difference between the mean and true apogees on the epicycle. His especial concern to explain that may be because the terminology is particularly confusing: the mean and true apogees on the epicycle are quite different from the planet's apogee on the ecliptic, and the equation of its anomaly on the epicycle is different from the equation of anomaly measured at the centre of the equatorium (Earth).[65]

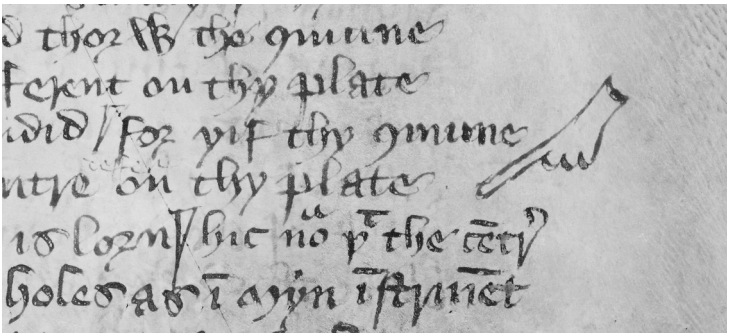

Figure 3: Maniculum. Peterhouse, Cambridge MS 75.I, fol. 76ᵛ. Reproduced by permission of the Master and Fellows of Peterhouse, Cambridge.

Such clarifying digression is a quite different direction from that taken by Chaucer, who wanders into general and even moral education in explaining, for example, the etymologies of the names of the months to Lewis.[66] It is clear that Westwyk wants his readers to go beyond a basic working knowledge towards true understanding of the underlying theory. It is likewise understanding that is being pursued when he goes beyond instructing his pupil to maintain the position of the common deferent centre, taking the trouble to give a reason for his instructions. He explains that 'yif thy commune centre different [*sic*] stirte fro the centre defferent on thy plate al thin equacion of thy planete desired is lorn.'[67] This explanation was sufficiently important to be marked with a pointing *maniculum*; the similarity of pen and ink to the text of the treatise make this very likely to be authorial (see Figure 3). A similar caution is urged by the author of some fifteenth-century instructions on the use of a lunar equatorium ('þe voluelle þat summen clepen a lunarie').[68] Switching between addressing his reader as 'ye' and 'we', he writes: 'First take we þe tunge of þe moone; & sette whe him on þe day of his age; & þanne take we þe tunge of þe sunne; & sette we hym on þe day of þe monþe þat it is of. But loke þat 3e sette not þat one for þe toþer; for so 3e my3te be deceyved.'[69]

Not only was English well suited to the communication of craft content; the choice of language for the *Equatorie* also had a significant impact on its pedagogy. John Westwyk's use of oral language has already been mentioned; it is most apparent in the way he used repetition for emphasis. Such emphatic repetition is, of course, not exclusive to English, but it was facilitated and made more common by the oral nature of the language at the time when the *Equatorie* was written. To take an example from the core function of the equatorium, the computation of the longitude of a superior planet; the author tells his reader to:

> put the comune centre defferent of thyn Epicicle up on the centre different in thy plate of thilke planete that thow desirest to have equacioun. I sey that with a nedle thow shalt stike the comune centre defferent of thin Epicicle up on the centre defferent that is perced on thy plate for swich a planete a the list [which you want] to have of equacoun.

The common epicycle thus fixed in place, the white thread is brought into play:

> under whiche white thred ley the pool [pole] of thyn epicicle and stondinge thyn epicicle stille in this maner – I seye stondinge the pool of thin epicicle undir thy white thred stille – and the commune centre different fix with thy nedle to the forseide centre defferent of the planete desired …[70]

We are thus told no less than three times that the common deferent centre is to be fixed to the deferent centre of the desired planet, and again thrice that the common epicycle is to be laid under the white thread; the reminder is rendered more forceful by the oral phrasing 'I sey' and 'forseide', suggesting that the author is looking over the reader's shoulder as we follow his instructions.

Such emphatic repetition is entirely absent from the instructions of Jean of Lignières and Richard of Wallingford, who, while explaining the use of their instruments perfectly clearly, nonetheless both describe each step only once. Perhaps Middle English was particularly well suited to didactic repetition, or at least such repetition was more widely acceptable within the conventions of its use. Such a supposition is supported by the parallel sundial texts in Aberdeen MS 123. An early passage instructs readers to draw a circle, divide it into quarters with two diameters, and then to mark the latitude for which the sundial is to be made within a quadrant of ninety degrees:

> Postea diuide 4 unam istius circuli in 90 g^{a}. Et tunc in 4^{a} ad postremo [*sic*] computa latitudinem regionis ad quam vis instrumentum componere incipiendo ab A versus D & vbi terminatur pone signum F.[71]

In English, this passage was significantly expanded:

> then devyde awharter of that cercle **fro A to D** in to 90 partes or degres, and take the latitude of the region or contre for whylk thou makys thyn instrument to serve in, and counte **fro A toward D**. As for the cyte of York, take the latitude therof that is 52 degres, whilk is the latitude of the forsayd cyte, and contre **fro A toward D**, and merke wele with a pryk wher 52 degres endes **toward D**, and set ther F.[72]

Readers may first be struck by the insertion of a concrete example, or by the practical tip to mark point F well with a prick, but here I wish to highlight the quadrupling of the instruction to count the latitude towards D. The translator does not deliberately draw attention to the fact he is repeating it in the way Westwyk does, but nonetheless he clearly wishes to stress this point.

A further striking feature of the Aberdeen text is the insistent use of the word 'then' to mark successive steps in the construction process. The Latin source text itself contained many of these structural markers: most commonly 'tunc' at the beginning of a sentence, but also a variety of other adverbs such as 'postea', 'postmodum', and 'quo facto'; eight different connectors are used a total of twelve times in this relatively short set of instructions. In translation, these are multiplied but also homogenized: of the seventeen instances where successive steps are signalled, twelve use 'then', and only four other words are used. Thus the translator has altered his source text to emphasize how the construction progresses, keeping the language simple and clear at every stage. John Westwyk used the same technique to add structure to his treatise, including the marker 'than(ne)' a total of 53 times.

Such simplification of instructions should not be taken as a sign that the author's understanding was itself simplistic. The assumption has tended to be made by historians that scholars always wrote at the limit of their own abilities, but there is no a priori reason why this should be the case.[73] In the case of the *Treatise on the Astrolabe*, it is accepted that Chaucer was writing well within his scientific limits because his childish audience is explicitly named, and he makes it clear that he is adapting his style and content to that audience. But such accommodations could also be made where the audience and methodology are not made explicit. For the Benedictine monk John Westwyk, and for the Augustinian friar who translated Aberdeen MS 123, translation may well have been a pastoral, charitable service of dissemination.[74] In the same way, and bearing in mind that the use of English might imply a less educated audience, it seems plausible that Westwyk deliberately adapted the content of his treatise for a less educated, English-speaking audience – simplifying it with pedagogic sophistication. Recognizing that authors tailored their work to their audience – not only in the prose used, but also in the way that diagrams are included, labelled, and referenced in the texts – is important to our understanding of technical writing in English.[75] Pedagogic prose, ranging from instructions through explanation to worked examples, was structured and composed in the way that best suited authors' practical purposes.

Vocabulary and stylistic innovation

The need for clarity was particularly acute when a writer employed vocabulary that was potentially unfamiliar to his reader. To a certain extent, use of new vocabulary must follow rather than precede its acceptance: a writer must be able to assume his readers will understand the terms he uses, and so neologism is often adaptive and incremental.[76] But where this was not possible, the writer needed to provide some form of explanation. Westwyk was assisted by the fact that many

of the terms he used had already appeared in the *Treatise on the Astrolabe*, a text with which he knew (or assumed) that his readers had some familiarity. As we have already seen, the 'midnyht line' on the equatorium was defined by explicit reference to the *Treatise on the Astrolabe*; another term, 'label', was implicitly defined by taking advantage of his reader's familiarity with the more common instrument.[77] This was done in a subtle but effective manner. Westwyk instructs his reader to begin with a 'rewle of latoun' (brass pointer):

> tak thanne **a rewle** of latoun … **this rewle** mot [must] be shape in maner of **a label** on an astrelabie. The centre of **this rewle** shal be nayled to the centre of the forseide barre in swich a manere that **this label** may torne abowte as doth the **label** of an astrelabie. In middes of this nayl that fastnyth the barre and the **label** togidere ther mot be a smal prikke.[78]

The word 'rewle' is used in two other senses in the treatise: to mean a principle or norm of practice, and to refer to a straight edge used to draw lines. Neither use was new at that time. On the other hand, the word 'label', in the sense of a metal pointer, does not appear in any other extant source prior to the *Equatorie* apart from the *Treatise on the Astrolabe*.[79] Thus Westwyk exploited his reader's greater familiarity with the word 'rewle' to help redefine the word 'label', a word with which the reader would have been a little acquainted. In the passage above we see him subtly introduce the new word by a gradual process of interwoven replacement. After this passage, 'rewle' is no longer used to describe that part of the instrument; it is only described (and a diagram is captioned) with the new word 'label', which appears a further twelve times in the treatise.

However, the *Equatorie* does contain several words or phrases that may appear in English for the first time. They are listed in the Appendix (below), together with some comparisons with other texts and languages. As we have seen, in nine cases Westwyk drew attention to his use of these words with phrases such as 'wole I clepe'; this was generally where he had taken a multi-word technical term and translated it into a new phrase that his reader might not immediately recognize, such as 'comune centre defferent'. More common, though, is his use of terms that were already established in Latin, which he adopted with few changes.[80] When he did this, he did not define the adopted words, which suggests that he expected his reader to have some familiarity with Latin terms such as *motus*, *aux*, and *eccentrik*, all of which probably have their first appearance in English in Peterhouse MS 75.I.[81] Of those three terms, *aux* (and its plural *auges*) are simply transferred intact from Latin, while the seven appearances of 'eccentrik' demonstrate consistent adaptation of the Latin term 'eccentricus'.[82] The case of *motus* is more complex. In eight cases Westwyk used the Anglicized 'mot', but in a further forty-nine he retained the Latin term (always abbreviated as 'mot9'). The cause of such inconsistency is unclear. The frequency with which

the shorter version appears makes it unlikely that he simply omitted the '9' character accidentally, and inadvertent confusion with 'mot' meaning 'must' seems implausible for the same reason. It seems more likely that he was simply undecided about whether or not to translate the word. The fact that the translated version is concentrated on four consecutive pages in the middle of the treatise (fols 76^{r}–77^{v}) suggests that at one point he decided that Anglicization would be appropriate, but later changed his mind.

A similar sort of bilingualism occurs with the word 'degre', a word that would have been familiar to any reader of the *Treatise on the Astrolabe*. Westwyk's handling of this is consistent: where he writes it out in full, he translates it (31 times in the treatise); where he abbreviates it, he uses the Latin abbreviation g^{a} (32 times).[83] The abbreviation tends to occur after a number, while the full version is more likely to be used in a passage of explanation, though that is not always the case. Still, it seems plausible that Westwyk was accustomed to using the Latin abbreviation in calculations and tended to persist in this when writing numbers, whereas in a passage of prose he perhaps found it more natural to use the established English form (itself taken from French).

Another established word, but one employed by Westwyk in a novel context, was 'mene'. Its use to denote 'intermediate', again with a root in Anglo-Norman, went back at least to the middle of the fourteenth century, but Westwyk was the first to use it in a strictly astronomical (or mathematical) sense.[84] It seems likely that he felt that the pre-existing general sense of the word was sufficiently close to the new technical sense to obviate the need to use the Latin adjective *medius*, or to provide a definition or explanation.

Apart from Latin, another language is present in the *Equatorie*: Arabic. The opening phrase 'in the name of god pitos & merciable' is certainly influenced by the Arabic 'bismillāhi r-raḥmāni r-raḥīm', and three words in the treatise are apparently of Arabic origin: *almenak*, *aryn*, and *alhudda*.[85] These are less likely to indicate a direct Arabic source text for the treatise than the indirect influence of Islamic-world astronomy. The *bismillah*, the invocation used by Muslims before any Qur'an reading, prayer, or other action requiring God's blessing, had become common by the fourteenth century, and was certainly being used in texts composed in Latin.[86] Likewise, *almenak* was well established in English (though its meaning varied, sometimes denoting a perpetually valid, flexible set of tables, at other times something more fixed and temporary), having passed into contemporary French and Spanish by the twelfth century; it appears in the *Treatise on the Astrolabe*, as well as a translation of the *Exafrenon* of Richard of Wallingford made in the late 1380s.[87] The second term, *Aryn*, which Westwyk uses to refer to the centre of his instrument, is a little more unusual. The name *Arim* (or *Aren*) was fairly commonly used in medieval geography to refer to the centre of the habitable earth, resulting from a corruption of the name of the

Indian city of Ujjain.[88] This usually meant zero or 90 degrees longitude on the surface of the earth, though zero latitude could also be assigned to that place.[89] It is not a great leap from such a global reference point to the very centre of the earth, and Westwyk was not the only astronomer to make such a leap.[90] In particular, it is perhaps worth noting an intermediate use in the astrolabe treatise of Rudolf of Bruges (*fl. c.*1144). In a fairly brief section concerning the uses of the astrolabe, Rudolf notes that at Arin, which is 'sub circulo recto' (i.e. on the equator), the days are of equal length throughout the year and therefore equal hours can always be used; the further one is from this, the greater the variation in unequal hours.[91] It is easy to see how the use of this explanatory detail in instrument treatises may have given rise to the application of the name *Aryn* to the centre of the instrument, which in the case of the equatorium is analogous to the centre of the Earth.[92]

Westwyk defines both *aryn* and *alhudda* explicitly. For the latter, he writes that 'thilke lyne that goth fro centre aryn un to the cercle closere of the sygnes … shal be cleped lyne alhudda'.[93] He may not have been the first person to make this association. A manuscript produced in Germany in the mid-fifteenth century, which contains a number of astrological treatises, incorporates a text headed 'Note [on] the foreign names which are found in authoritative works.'[94] Among various familiar and unfamiliar Arabic terms is the following definition: 'Alucha id est linea medij celi.'[95] The line of midheaven, or meridional line, was the line running from the centre to the top of an astrolabe plate, just as 'lyne alhudda' runs on the equatorie (see Figure 2); and Westwyk himself uses the term 'meridional lyne' in preference to 'lyne alhudda' in the latter part of his treatise.[96] This may suggest that Westwyk was using a different source text for that part, but we would need more evidence to be sure of that. Since they share a definition, it seems likely that *alhudda* and *alucha* are distortions of the same word, and that Westwyk was using a term that was circulating in some Latin texts at this time.[97]

Of the four instances of Arabic words or phrases, two are certainly somewhat commonplace or conventional, while the other two are both found in at least one Latin treatise, and in the *Equatorie* are probably used outside what in Arabic would be their correct astronomical context. It thus seems most likely that the *Equatorie* treatise contains these few Arabisms not because it was translated from a single Arabic source, but because its author adopted them from other texts he had read. There is a slight sense that such terms had exotic allure.

Since clarity was paramount in the *Equatorie*'s composition, it should not be surprising that it is relatively free from neologisms. Although the *Middle English Dictionary* cites Peterhouse MS 75.I as the earliest source for dozens of words, in many cases, such as 'difference', 'marke', or 'crois', the meaning was so close to a pre-existing usage as to be almost indistinguishable.[98] Other cases, such as

'boydekyn' or 'karte whel', concern everyday items whose names surely cannot have been invented by a Benedictine monk for use in an astronomical treatise. As the Appendix shows, the list of genuine coinages in the manuscript is quite short, and they are invariably signalled as such by the writer himself.

There is a further group of words whose only known appearance prior to the *Equatorie* is in the *Treatise on the Astrolabe* or some other work by Chaucer. R. M. Wilson numbered 35 such instances, but Stephen Partridge, taking account of the appearances of some of these words in Trinity College MS O.5.26 and supposed differences in usage between the *Astrolabe* and *Equatorie*, subsequently reduced this to 7.[99] Partridge was very strict on the question of usage because the purpose of his analysis was to see if common words between the two treatises could be used to argue for Chaucer's authorship of Peterhouse MS 75.I, but the thrust of his analysis is relevant here: the more manuscripts from this period we examine, the less exceptional the vocabulary of the *Equatorie* turns out to be: it could hardly be otherwise, if Westwyk wanted his readers to understand his treatise. Partridge even dismisses the significance of the seven words that are shared by the *Equatorie* and *Astrolabe*, stating simply that the shared unusual vocabulary 'can be explained … by the fact that they are two of the earliest Middle English treatises on scientific instruments'.[100] That is, no doubt, true. But in that case it is particularly noteworthy that Westwyk needed to define so few words. Instead, he took advantage of his audience's familiarity with the *Treatise on the Astrolabe*, as well as with a few Latin terms that he brought into English perhaps for the first time. Where he may have been unsure that his audience would understand the Latin term, he modified the sense of existing English words such as 'drawe out' (to mean 'subtract'), or created new derivative forms such as '[en]closer'.

Such modifications are typical of what Butcher has termed 'vernacular behaviour' in this period.[101] The fluid use of language, allowing the incremental construction of new vocabularies and identities, was a symptom of the increased use of English in many settings. The permeable boundaries between Latin, French (whose influence is particularly apparent where adjectives follow nouns), and English, and between oral and written uses of the language, gave Westwyk great flexibility for the adaptation of his Latin source text (or texts). It has long been accepted that the process of translation afforded significant scope for self-expression, but what the *Equatorie* and related manuscripts show is that this applied to astronomical material as much as other subjects. When we see the Augustinian friar of Warrington trying out different English spellings, or translating Hindu-Arabic numerals in a Latin text back into their Roman equivalents in the English version, we are witnessing processes of learning and experimentation that helped shape Middle English scholarship.

Conclusion

The *Equatorie of the Planetis* exemplifies a pragmatic flexibility in the employment of language. Its use of the vernacular is perfectly suited to the register in which its author sought to communicate, and although communities of astronomers crossed institutional and geographic boundaries, the *Equatorie*'s plain, oral English is indicative of a specific craft environment.[102] The text seems to be written by a scholar for a craftsman, perhaps even a particular individual reader; yet in its carefully constructed words we also seem to witness a dialogue between a scholar and a craftsman within the persona of the author himself. Despite strident critiques of Edgar Zilsel's thesis that interaction between artisans and scholars was a cause of the Scientific Revolution, his medieval dichotomy between these groups has remained stubbornly intact. Yet the kinds of astronomical communities epitomized by the *Equatorie of the Planetis* present a challenge to that dichotomy, as scholarship and craftsmanship are blended both in the instrument itself, and in the way it was communicated by John Westwyk. The practical nature of the treatise is what first strikes a reader, but closer examination reveals a deeper intent. The treatise informs, educates, warns, tells a story, recommends, and motivates; in short, it teaches. Westwyk exploited and expanded the linguistic range of his reader; but he was not just transmitting terminology: his Middle English – and occasional Latin – was a tool to clearly convey the technical and practical information necessary for the construction and use of his equatorium. In turn, the equatorium itself would be a tool for learning astronomical concepts, as well as simply finding planetary positions.

A close reading of the *Equatorie of the Planetis*, in conjunction with other texts, has enabled us to reconstruct these teaching and learning processes. Elsewhere in Peterhouse MS 75.I Westwyk may cite Roger Bacon, but his plain, oral diction is a world away from the academic milieu Bacon describes, where scholars were equally at home in English, French, or Latin.[103] His clarity is perfect for this dialogue between scholar and craftsman. His language use is as pragmatic as his language choice. He minimized neologisms and where they were required he modified the sense of existing words, or borrowed words from his reading in Arabic-influenced Latin sources. The result was a readable and admirably practical guide, which made creative use of the flexible, developing language of Middle English.

The close reading of the *Equatorie* offered here also helps to elucidate scholarly practices in the wider astronomical community from which this text arises. Westwyk was certainly not alone in his pragmatic approach to composition and translation. We see it too in Aberdeen MS 123, where the translator ignored sentences that dealt with purely theoretical matters. Furthermore, comparable approaches existed in other sciences, as when descriptions situate the practices

of alchemy 'between mechanical and liberal arts'.[104] These approaches allowed writers to find a voice appropriate to the material they wished to communicate: thus the *Equatorie*'s use of the vernacular facilitated its author's blend of astronomical scholarship with practical craftsmanship. It might, therefore, be better to categorize this and similar texts within a mixed class of scholarly craft writing. Works in such a class, while ostensibly addressing different subjects, may share similar pedagogical aims, practical modes of address, and flexible uses of language. Moreover, as several of the texts we have examined come from religious houses whose members had an obligation to teach, they may also share charitable motivations.[105] Study of the *Equatorie of the Planetis* and other treatises through the lens of vernacular craft writing allows us to look beyond the simplest categorization of works according to their basic subject matter, and to think more carefully about the authors and audiences of texts, in order to gain a deeper understanding of how ideas were communicated in the fluid and fast-evolving languages of the later Middle Ages.

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Appendix

Noteworthy technical terms used in Peterhouse MS 75.I

This appendix presents a selection of the technical terms in the *Equatorie of the Planetis* according to three categories: those explicitly explained or defined in the treatise; those that may make their first English appearance in this manuscript;[106] and other terms worthy of note.

The second group is significantly reduced in size by the fact that the *Equatorie* was composed after the *Treatise on the Astrolabe*;[107] several terms are only recorded there prior to their use in Peterhouse MS 75.I . However, many of those are in any case uninteresting since they are direct transliterations from Latin; a few more interesting terms have been included in group C.

In each case, the word or phrase from the *Equatorie* is presented in the first column. The second gives the equivalent term used in Latin treatises. The terms in that column have been drawn from a range of sources that describe equatoria and related instruments.[108] The third column contains equivalent terms in Arabic, most of which are taken from studies by Paul Kunitzsch and Jamil Ragep.[109] The fourth column contains any relevant notes and explanation.

1. *Words explicitly defined by John Westwyk (using the verbs callen or clepen)*

Equatorie	**Latin**	**Arabic**	**Notes**
centre aryn	centrum; centrum terrae	al-markaz (centre), al-quṭb (pole, axis)	*Aryn* was thought to be the centre of the habitable earth (see discussion above). It also appears in the astrolabe treatise of Rudolf of Bruges (s. xii^{med}).[110] The equivalent on an astrolabe is the 'pole'.
closere (of the signes)	~ circulus signorum; firmamentum	~ falak al-burūj	This is the first recorded use of the word 'closer' (meaning an enclosure). Other treatises do not explicitly define this part of their instrument, which might be called the 'ecliptic'.
comune centre defferent	(centrum deferentis, regula semidiametri deferentis communis)	(markaz al-khārij)	This component is unique to the *Equatorie*; the phrases given are the nearest phrases used in other treatises.
degres of the semidyametre	partes semidiametri	ajzā' (or daraj) niṣf al-quṭr	These degrees are divisions (60^{ths}) of a semidiameter used to mark out the Sun's eccentricity. They are not given a special name in other treatises.
equacioun of his argument	equatio argumenti	zāwīya al-'ikhtilāf	Defined by Westwyk as the angle between the true longitude of the epicycle centre and the true longitude of the planet.
equacioun of his centre	equatio centri	ta'dīl al-markaz	Defined by Westwyk as the angle between the true longitude of the epicycle centre and the mean longitude of the planet.
lymbe	limbus	al-ḥujra	This is the first recorded use of the word 'limb' as the extremity of any object, though its anatomical meaning was well established. Chaucer's *Treatise on the Astrolabe* uses 'bordure' for the equivalent part.
lyne alhudda	linea medii celi	khaṭṭ wasaṭ as-samā'	The Latin treatises consulted do not explicitly define these components, which are not important to their instruments. The terms 'linea meridiei' and 'linea medie noctis' are common in astrolabe treatises.
midnyht line	oppositio	khaṭṭ az-zawāl	
remenaunt, remnaunt	quod remanet; quod relinquitur; residuus	baqīya	This word is used in two senses: the rest (e.g. of the planets); and remainder after subtraction. It is only new (and defined) in the second sense in the *Equatorie*.

2. *Words that make their first recorded appearance in Peterhouse MS 75.I*

Equatorie	**Latin**	**Arabic**	**Notes**
aux, auges	aux, auges	ʾawj	This word does not appear in the *OED* or *MED*; it is quite likely that Peterhouse MS 75.I represents its first appearance in an English manuscript.
diametral	diametraliter (adv.)	quṭrī	
drawe (owt)	subtraho	naqaṣa (min)	This is the first recorded use of this word to mean 'subtract', though 'withdraw', which was not a new word at that time, is the word generally used in the *Equatorie*.
eccentrik	eccentricus	khārij markaz	
equant	equans	muʿadil al-masīr	
equatorie	equatorium, instrumenti	- ʿādil	This word does not appear in the *OED* or *MED*; it is quite likely that Peterhouse MS 75.I represents its first appearance in an English manuscript. It is hardly ever used in Latin treatises: of the four consulted, it only appears in the title of Jean of Lignières's treatise, and then only in some manuscripts.
equedistant	equedistanter (adv.)	yatawāzā	This adjective is used to mean 'parallel' in the *Equatorie*
geometrical	geometricus	bil-khuṭūṭ	
mot, motus	motus	ḥaraka	This word does not appear in the *OED* or *MED*; it is quite likely that Peterhouse MS 75.I represents its first appearance in an English manuscript.
precisely, precise (adv)	precise	bitadqīq	
seccioun	sectio	(nuqṭa) taqāṭuʿ	meaning intersection
semydiametre	semydyameter, semidiameter	niṣf al-quṭr	

3. *Other noteworthy terms*

Equatorie	**Latin**	**Arabic**	**Notes**
almenak	tabulae; almanac	taqwīm	Apparently of Arabic origin, though its etymology is debated. See the discussion in Benjamin and Toomer, *Campanus of Novara*, 374f. It is not clear whether the almanac referred to by John Westwyk was time-limited or perpetual.
label	regula, lingua, lingula	al-ʿiḍāda (alidade)	Westwyk gently calls attention to the meaning of this word, which he has already used for an analogous part of an astrolabe.
mene	medius	wasaṭ	This is the first time the word is used in a strict mathematical sense (rather than meaning intermediate). It appears in the Supplementary Propositions to the *Treatise on the Astrolabe*.
retrogradorum	planeta	rāji‘	This word appears in a passage of ciphered English text among the tables, where it clearly refers to the planets (stars capable of retrogradation). The same genitive form was used by John Somer.[111] It is rarely used in Latin texts as a noun synonymous with *planeta*, but the adjective *retrogradus* is common.
visage	facies, mater	aṣ-ṣāfiḥa (plate)	This is the first time the word is used to mean the front of an instrument. Westwyk also uses the word ‘face’.

NOTES

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[1] Edgar Zilsel, ‘The sociological roots of science’, *The American Journal of Sociology*, 47 (1942), 544–62, repr. in *Social Studies of Science*, 30 (2000), 935–49 (p. 942). See also Rupert Hall, ‘The scholar and the craftsman in the scientific revolution’, in *Critical Problems in the History of Science*, ed. Marshall Clagett (Madison, Wis., 1959), pp. 3–23 (p. 21).

[2] *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Early Industrialisation*, ed. Lissa Roberts, Simon Schaffer, and Peter Dear (Amsterdam, 2007), represents a sustained recent critique of Zilsel’s thesis. It is partially defended and updated in Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400–1600* (Corvallis, Ore., 2011), but Long maintains the position that ‘there was an explicit and obvious divide between the learned Latin culture of the medieval universities and the vernacular, skill-based craft cultures of artisanal production in urban centers’ (Pamela O. Long, review of *The Mindful Hand*, ed. Roberts, Schaffer, and Dear, *Nuncius*, 24 (2009), 216–18 (p. 218)).

[3] Larry D. Benson, 'Introduction', in *The Riverside Chaucer*, ed. Larry D. Benson (Oxford, 1988), pp. xi–xliii (p. xxiii). The *Equatorie* treatise has been published twice (*The Equatorie of the Planetis*, ed. Derek J. Price (Cambridge, 1955), pp. 18–44; and a diplomatic transcription in Kari Anne Rand Schmidt, *The Authorship of the Equatorie of the Planetis* (Cambridge, 1993), pp. 115–43), but the most recent and accessible version, based on Rand Schmidt but including a transcription of the whole manuscript, is the one accompanying the digitized manuscript, at http://cudl.lib.cam.ac.uk/view/MS-PETERHOUSE-00075-00001 (2014). For this reason, references to the *Equatorie* treatise and wider manuscript will be to folios, rather than to the pages of either edition.

[4] Derek J. Price, 'Chaucer's astronomy', *Nature*, 170 (1952), 474f.

[5] The historian of astronomy John North expressed doubts in a series of articles published in 1969 (J. D. North, 'Kalenderes enlumyned ben they: some astronomical themes in Chaucer', *The Review of English Studies*, 20 (1969), 129–54, 257–83, 418–44 (pp. 433–6)); but by 1988 was convinced Chaucer was the *Equatorie* author (J. D. North, *Chaucer's Universe* (Oxford, 1988), pp. 169–81). S. S. Hussey appears to have changed his mind within the space of a page, first describing the *Equatorie* and *Treatise on the Astrolabe* as 'his two prose scientific works written at the beginning of the last decade of his life', before cautioning that 'we cannot be certain that the *Equatorie* … is really Chaucer's work' (S. S. Hussey, 'The minor poems and the prose', in *History of Literature in the English Language*, Vol. 1: *The Middle Ages*, ed. W. F. Bolton (London, 1970), pp. 229–62 (pp. 251f.)). A summary of the first forty years of the debate is provided in Rand Schmidt, *The Authorship*, pp. 3–14.

[6] Kari Anne Rand, 'The authorship of *The Equatorie of the Planetis* Revisited', *Studia Neophilologica*, 87 (2015), 15–35. Westwyk's is not the only hand in Peterhouse MS 75.I: the majority of its tables are in another hand, and there is a small number of marginal comments in a third. However, the thematic coherence of the manuscript, and the presence of annotations by Westwyk on tables he had not himself written out, suggest that it was his compilation. For Robinson's discussion, see Introduction to *The Works of Geoffrey Chaucer*, 2nd edn, ed. F. N. Robinson (London, 1957), pp. viii–ix.

[7] Derek J. de Solla Price, *Science since Babylon*, enl. edn (New Haven, Conn., 1975), p. 27. Price was presumably using M. R. James's *Descriptive Catalogue of the Manuscripts in the Library of Peterhouse* (Cambridge, 1899); this gives the Latin incipit to the codex, but does also note that the treatise beginning on fol. 71^{v} is in English. Price's discovery of, and writing about, the manuscript is discussed in Seb Falk, 'The scholar as craftsman: Derek de Solla Price and the reconstruction of a medieval instrument', *Notes and Records: The Royal Society Journal of the History of Science*, 68 (2014), 111–34.

[8] Derek J. Price, 'Chaucer's astronomy', *Nature*, 170 (1952), 474f. (p. 474). On the dating of the *Astrolabe*, see 'Introduction' to Geoffrey Chaucer, *A Treatise on the Astrolabe*, ed. Sigmund Eisner (Norman, Okla, 2002), pp. 15–17. The *Equatorie* was written during the first nine months of 1393 (Westwyk refers to 1392 in the past tense, and, elsewhere in the manuscript, the entry of the Sun into Libra in 1393 in the future tense; see North, *Chaucer's Universe*, p. 171).

[9] Chaucer, *A Treatise on the Astrolabe*, Prologue, lines 62–70, ed. Eisner, pp. 109–11. Price later admitted that 'there is by no means complete correspondence between the contents of the Peterhouse volume and the five parts announced in the Prologue of the *Astrolabe*', but suggested that 'such deviation from the stated plan is not uncommon … and a problem

such as this is not unlikely to arise when an author writes the preface before the main chapters of his book' (Price, *The Equatorie of the Planetis*, p. 157).

[10] Anna-K. Mayer, 'Setting up a discipline: conflicting agendas of the Cambridge History of Science Committee, 1936–1950', *Studies in History and Philosophy of Science Part A*, 31 (2000), 665–89; Falk, 'The scholar as craftsman', pp. 112–14.

[11] Derek de Solla Price, 'Philosophical mechanism and mechanical philosophy: some notes towards a philosophy of scientific instruments', *Annali dell'Istituto e Museo di Storia della Scienza di Firenze*, 5 (1980), 75–85 (p. 76).

[12] Examples of approaches which compare the language of the *Equatorie* and *Astrolabe* are two articles in *English Manuscript Studies 1100–1700: Volume 3*, ed. Peter Beal and Jeremy Griffiths (London, 1992): Larry Benson, 'Chaucer's spelling reconsidered' (pp. 1–28); and Stephen Partridge, 'The vocabulary of the *Equatorie of the Planetis* and the question of authorship' (pp. 29–37).

[13] A sense of the range of the vernacular by this period is given in *The Idea of the Vernacular: An Anthology of Middle English Literary Theory, 1280–1520*, ed. Jocelyn Wogan-Browne et al. (Exeter, 1999); the subtitle of this anthology belies the variety of its contents.

[14] Linda Ehrsam Voigts, 'What's the word? Bilingualism in late-medieval England', *Speculum*, 71 (1996), 813–26; Päivi Pahta, 'Code-switching in medieval medical writing', in *Medical and Scientific Writing in Late Medieval English*, ed. Irma Taavitsainen and Päivi Pahta (Cambridge, 2004), pp. 73–99.

[15] The expansion in the use of the vernacular for scientific writing has been amply shown by the many manuscripts assembled by Linda Ehrsam Voigts and Patricia Deery Kurtz for their database of *Scientific and Medical Writings in Old and Middle English* (eVK2), accessible at http://cctr1.umkc.edu/search. The project is explained in Linda Ehrsam Voigts, 'Multitudes of Middle English medical manuscripts, or the Englishing of science and medicine', in *Manuscript Sources of Medieval Medicine*, ed. Margaret R. Schleissner (New York, 1995), pp. 183–95. On the varied pace of vernacularization, see Päivi Pahta and Irma Taavitsainen, 'Vernacularisation of scientific and medical writing in its sociohistorical context', in *Medical and Scientific Writing in Late Medieval English*, ed. Irma Taavitsainen and Päivi Pahta (Cambridge, 2004), pp. 1–22; on astronomical writing, see Linda Ehrsam Voigts, 'The *Declaracions* of Richard of Wallingford: a case study of a Middle English astrological treatise', in *Medical and Scientific Writing in Late Medieval English*, ed. Taavitsainen and Pahta, pp. 197–208. John Hagge, 'The first technical writer in English: a challenge to the hegemony of Chaucer', *Journal of Technical Writing and Communication*, 20 (1990), 269–89, addresses particular attention to the register of technical writing, critiquing a number of recent historians who have accepted uncritically Robert T. Gunther's 1929 assertion that Chaucer's *Astrolabe* was 'the oldest work written in English upon an elaborate scientific instrument' (R. T. Gunther, *Early Science in Oxford*, vol. V: *Chaucer and Messahalla on the Astrolabe* (Oxford, 1929), p. v). It is also worthwhile to compare language choice in other fields; see, for example, Gwilym Dodd, 'The spread of English in the records of central government, 1400–1430', in *Vernacularity in England and Wales, c.1300–1550*, ed. Elisabeth Salter and Helen Wicker (Turnhout, 2011), pp. 225–66.

[16] Tony Hunt, 'An Anglo-Norman practica geometriae: edition and commentary', *The Mediaeval Journal*, 1 (2011), 37–52.

[17] Derek J. de Solla Price, 'The little ship of Venice: a Middle English instrument tract',

Journal of the History of Medicine and Allied Sciences, 15 (1960), 399–407 (p. 401); quotation from Michela Pereira, 'Alchemy and the use of vernacular languages in the late Middle Ages', *Speculum*, 74 (1999), 336–56 (p. 356).

[18] For vernacular Spanish in Alfonsine astronomy, see the work of José Chabás and Bernard Goldstein, especially *The Alfonsine Tables of Toledo* (Dordrecht, 2003). There were of course French examples: see *Translations médiévales: cinq siècles de traductions en français au Moyen Âge (XIe–XVe siècles)*, ed. Claudio Galderisi (Turnhout, 2011); and, for an astronomical case study, Jean-Patrice Boudet and Matthieu Husson, 'The earliest astronomical tables in French (*c.*1271)', *Journal for the History of Astronomy*, 43 (2012), 287–98. John Westwyk himself copied an excerpt of an Anglo-Norman treatise on some syzygy tables, in London, British Library, Harley MS 4664, fol. 125^{v}.

[19] He was responsible for a compilation and commentary on Richard of Wallingford's *Albion* treatise, in Oxford, Bodleian Library, MS Laud Misc. 657, fols 1^{v}–45^{r}.

[20] See, for example, R. M. Wilson, 'Linguistic analysis', in Price, *The Equatorie of the Planetis*, pp. 137–48; Rand Schmidt, *The Authorship*, pp. 74–84; Benson, 'Chaucer's spelling reconsidered'.

[21] Rand Schmidt, *The Authorship*, used the navicula text *The Shippe of Venyse*, and the anonymous translation of Andalò di Negro's *Theorica planetarum*, both in Cambridge, Trinity College, MS O.5.26, as 'non-Chaucerian controls' (p. 61). On the former, see Catherine Eagleton, *Monks, Manuscripts and Sundials: The Navicula in Medieval England* (Leiden, 2010).

[22] Partridge, 'Vocabulary', p. 31.

[23] The inclusion of Chaucer among the 'great men of science' owes much to the work of Robert T. Gunther. For clear statements of his views, see R. T. Gunther, *Early Science in Cambridge* (Oxford, 1937), p. v, and *Early Science in Oxford*, vol. V: *Chaucer and Messahalla on the Astrolabe* (Oxford, 1929), p. v.

[24] Voigts, 'What's the word?'

[25] *The Crafte of Nombrynge*, London, British Library, Egerton MS 2622, fols 136a–165a (*c.*1425), ed. Robert Steele, *The Earliest Arithmetics in English* (London, 1922), pp. 3–32; Anon, *The Crafte of Graffynge & Plantynge* (London, *c.*1518). Cf. *The Art of Nombryng* (a translation of the *Algorismus* (*c.*1225) of John of Sacrobosco), in Steele, *The Earliest Arithmetics*, pp. 33–51. Other examples are noted in George R. Keiser, *A Manual of the Writings in Middle English, 1050–1500*, vol. 10, *XXV: Works of Science and Information* (New Haven, Conn., 1998). It should be noted that titles were frequently added by later copyists; '*The Equatorie of the Planetis*', for example, was added by its 1950s editor to the untitled authorial draft in Peterhouse MS 75.I (Price, *The Equatorie of the Planetis*, p. 5).

[26] John Gower, *Confessio Amantis*, VII.1691–3, ed. Russell A. Peck (Kalamazoo, Mich., 2004), pp. 302f.

[27] Chaucer, *Astrolabe*, Prol. 7. On the ascription to Māshā'allāh ibn Atharī (*c.* 740–815) of the widely circulating compilation on the construction and use of the astrolabe, see Paul Kunitzsch, 'On the authenticity of the treatise on the composition and use of the astrolabe ascribed to Messahalla', *Archives Internationales d'Histoire des Sciences*, 31 (1981), 42–62.

[28] J. D. North, *Richard of Wallingford: An Edition of his Writings*, 3 vols (Oxford, 1976), II, 261.

[29] Chaucer, *Astrolabe*, Prol. pp. 54f.

[30] Compare, for example, the equatorium (*Theorica planetarum*) of Campanus of Novara, in *Campanus of Novara and Medieval Planetary Theory: Theorica Planetarum*, ed. Francis S. Benjamin and G. J. Toomer (Madison, Wis., 1971). Campanus' contemporaries were well aware that the construction of his equatorium was impracticable.

[31] Cambridge, Peterhouse, MS 75.I, fol. 71^{v}.

[32] Peterhouse 75.I, fol. 71v.

[33] Peterhouse 75.I, fols 76^{r}, 72v.

[34] Peterhouse 75.I, fol. 74^{r}. 'I conseile the ne write no names of signes til þat thow has proued þat thi comune centre defferent is treweli & justli set in direct of the closere of the signes of thin equatorie.'

[35] Peterhouse 75.I, fol. 73^{v}. 'yif thow myshappe in this cas i shal teche the aremedie: knokke thi centre defferent innere or owtre til it stonde precise up on the closere of the signes in the lymbe of thin equatorie'.

[36] John Davis, 'A very early description of a horizontal dial in English', *Bulletin of the British Sundial Society*, 24 (2012), 12–15.

[37] University of Aberdeen MS 123, fol. 66^{v}. Orthography has been edited in the same way as with Peterhouse, 75.I.

[38] A similar freedom is apparent in the translated canons analysed in Jean-Patrice Boudet and Matthieu Husson, 'The earliest astronomical tables in French (*c*.1271)', *Journal for the History of Astronomy*, 43 (2012), 287–98.

[39] Peterhouse 75.I, fol. 71^{v}.

[40] 'Orthogonal' and 'orthogonally' are not listed in the *Middle English Dictionary* (ed. Frances McSparran (Ann Arbor, Mich., 2001), https://quod.lib.umich.edu/m/middle-english-dictionary); the first reference for both in the *Oxford English Dictionary* is Leonard Digges's *Geometrical Practise, named Pantometria* (1571) ('orthogonally, adv.', *OED Online,* http://www.oed.com/view/Entry/132823).

[41] Aberdeen MS 123, fols 66^{r}, 67^{v}.

[42] Jose A. Camacho, *Null Subjects* (Cambridge, 2013).

[43] Andrew Butcher, 'Textual production and vernacular behaviour: locating a fifteenth-century administrative book', in *Vernacularity in England and Wales*, ed. Salter and Wicker, pp. 295–311 (p. 300).

[44] On this problem, see David Bellos, *Is That a Fish in your Ear? The Amazing Adventure of Translation* (London, 2012), pp. 50–2, 108f.

[45] Ralph W. V. Elliott, *Chaucer's English* (London, 1974), p. 142. Hagge ('First Technical Writer', pp. 280f.) disputes the simplicity of Chaucer's prose, as a part of his argument for greater continuity between 'Old English and the beginnings of vernacular technical prose'. It should also be noted that Chaucer's somewhat scholarly, Latinate register in the *Astrolabe* is quite different from the English verse register found in the *Canterbury Tales*.

[46] Westwyk's instructions were followed in the construction of the interactive virtual equatorium accessible alongside the digitised manuscript, at http://cudl.lib.cam.ac.uk/view/MS-PETERHOUSE-00075-00001. For Price's reconstruction of the equatorie according to Westwyk's instructions, see Falk, 'The scholar as craftsman'.

[47] Dodd, 'The spread of English', p. 228.

[48] Dodd, 'The spread of English', pp. 264–6.

[49] On the linguistic concept of 'domains' to analyse language mixing in medieval contexts,

see Voigts, 'What's the word?' Technical treatises like the *Equatorie* can move between different domains, or inhabit multiple domains simultaneously.

[50] Jean of Lignières, *Compositio equatorii secundum Johannem de Lineriis*, Brussels, Royal Library, MS 10124, fols 142^{v}–146^{r}, ed. Price, *The Equatorie of the Planetis,* pp. 188–96; Richard of Wallingford, *Tractatus albionis*, ed. North, *Richard of Wallingford*, I, 245–401.

[51] Sigmund Eisner, 'Chaucer as a technical writer', *The Chaucer Review*, 19 (1985), 179–201, (pp. 179f.). Alain Bernard and Christine Proust, 'General introduction', in *Scientific Sources and Teaching Contexts throughout History: Problems and Perspectives*, ed. Alain Bernard and Christine Proust (Dordrecht: 2014), pp. 1–15, criticize historians' assumptions of pedagogical purposes in texts.

[52] Peterhouse 75.I, fol. 71^{v}.

[53] Peterhouse 75.I, fol. 72^{v}. There were other treatises on the astrolabe, but none that we know of in English, and Chaucer's *Astrolabe* indeed uses that English phrase. Elsewhere in the manuscript John Westwyk cites Chaucer explicitly. These facts allow us to state with confidence that the *Treatise on the Astrolabe* was composed (at least in part) before the *Equatorie*.

[54] Lignières, *Compositio equatorii*, p. 188. 'Let the edges [limbi] on each side be raised up a little, like the mater of an astrolabe.' Price transcribes 'membris' instead of 'matris'; I have been unable to check the manuscript he used, but the copy in Oxford, Bodleian Library, MS Digby 168, fol. 64^{r}, certainly says 'matris'. 'Membris' would be grammatically incorrect.

[55] See, for example, Richard of Wallingford, *Tractatus albionis* I.1f., ed. North, I, 340–6.

[56] Peterhouse 75.I, fol. 71^{v}.

[57] Chaucer, *Astrolabe*, Prol. 36–40; 1.16.

[58] The word counts in this chapter are taken from K. A. Rand Schmidt and J. L. Dawson's 'Concordance to *The Equatorie of the Planetis*', in Rand Schmidt, *The Authorship*, pp. 283–407.

[59] This includes sixteen instances of 'thi', twenty-two of 'thin', and fifteen of 'thyn'.

[60] Peterhouse 75.I, fol. 74^{r}.

[61] See, for example, Chaucer, *Astrolabe*, 2.1.

[62] On such forms of address, see Irma Taavitsainen, 'On the evolution of scientific writings from 1375–1675: repertoire of emotive features', in *English Historical Linguistics 1992*, ed. Francisco Moreno Fernández, Miguel Fuster, and Juan José Calvo (Amsterdam, 1994), pp. 329–42.

[63] Peterhouse 75.I, fol. 73^{v}. Again, here we may see the influence of Chaucer, who employed self-deprecation in the *Astrolabe*, such as when he excuses his 'naked wordes' (Prol. 53).

[64] Seth Lerer, 'Chaucer's sons', *University of Toronto Quarterly*, 73 (2004), 906–15 (p. 912). On the moral implications of astrology, see Hilary M. Carey, *Courting Disaster: Astrology at the English Court and University in the Later Middle Ages* (Basingstoke, 1992), pp. 8–20.

[65] This repetition of terms was confusing enough to cause problems for the normally dependable Price, who mislabelled a diagram in his edition of the manuscript (Price, *The Equatorie of the Planetis*, p. 108).

[66] Chaucer, *Astrolabe*, 1.10.

[67] Peterhouse 75.I, fol. 76^{r}.

[68] Oxford, Bodleian Library, MS Ashmole 191, fols 197^{v}–211^{r}, at 199^{r}.

[69] Ashmole 191, fol. 199^{v}.

[70] Peterhouse 75.I, fol. 75^{r}.

[71] Aberdeen 123, fol. 66^{r}.

[72] Aberdeen 123, fols 66^{v}–67^{r} (orthography edited).

[73] See, for example, the remarks of John North about the authors of scientific writings in Middle English: North, *Richard of Wallingford*, II, 94.

[74] Faye Marie Getz, 'Charity, translation, and the language of medical learning in medieval England', *Bulletin of the History of Medicine*, 64 (1990), 117. Scholarly activities like glossing and copying were papally promoted as pious labour (W. A. Pantin, 'The general and provincial chapters of the English black monks, 1215–1540', *Transactions of the Royal Historical Society*, 10 (1927), 195–263 (pp. 209f.)). Translation – perhaps originally from an Arabic source – can also be seen as a quasi-political form of *translatio studii*.

[75] There are, it should be admitted, places in the text where Westwyk is still learning as he writes. See Seb Falk, 'Learning medieval astronomy through tables: the case of the *Equatorie of the Planetis*', *Centaurus*, 58 (2016), 6–25.

[76] Dodd ('The spread of English', pp. 250f.) has discussed how the standardization of English may have been a necessary precursor to its use in government documents.

[77] Authors of equatorium treatises invariably assumed their readers would have some familiarity with the astrolabe, referring to it in their explanations. See, for example, Campanus of Novara, *Theorica planetarum* 2.77, ed. Benjamin and Toomer, *Campanus of Novara*, p. 142; Lignières, *Compositio equatorii*, p. 188.

[78] Peterhouse 75.I, fol. 73^{r}.

[79] The data on usage and appearance is taken from the *Middle English Dictionary* (ed. McSparran).

[80] A striking comparison may be made with the roughly contemporary Irish astronomical tract *Da Cailibh na Firmaminnti & na Ceithre Dula*, which was in part a translation of (pseudo-) Māshā'allāh's *De scientia motus orbis*. In this case the translator created many more new astronomical terms in Irish instead of simply adopting Latin terms. See John A. Williams, 'The Irish astronomical tract: a case study of scientific terminology in 14th century Irish' (unpub. M.Phil. thesis, University of Sydney, 2002). On the attribution of this and other works to Māshā'allāh, see Taro Mimura, 'The Arabic original of (ps.) Māshā'allāh's *Liber de orbe*: its date and authorship', *The British Journal for the History of Science*, 48 (2015), 321–52.

[81] The spelling 'mote' appears in the Supplementary Propositions to the *Treatise on the Astrolabe*, but these were probably written a few years later (Eisner, 'Textual commentary' to *A Treatise on the Astrolabe*, pp. 43–6). That spelling is not used in the *Equatorie*.

[82] It is on one occasion spelt 'eccentric'. Another example is provided by the two instances of 'meridie', which was not an entirely new word. These could be thought to be a faithful rendering of the Latin ablative, which would be appropriate in the context, but Westwyk did not decline any other Latin loanword in the treatise so that seems unlikely. (One Latin loanword is declined among the tables (fol. 38^{v}), where the word *retrogradorum* (referring to the planets) appears in a ciphered passage.) North (*Chaucer's Universe*, p. 188) calls attention to the use of this word in a Latin canon on fol. 45^{r}, suggesting that this unusual usage might be evidence of a link to John Somer.

[83] There is one exception to this: *g^{a}d* on fol. 78^{v}.

[84] This word also appears in the Supplementary Propositions to the *Treatise on the Astrolabe* (2.44), but these probably postdate the *Equatorie*, as already mentioned.

[85] There is also an incomplete list of stars, including many Arabic names, on fol. 71r. Although its inclusion of meridian altitudes for some stars at London, which Westwyk seems to claim to have measured himself (he writes 'cuius rei expertus sum'), is noteworthy, the list itself is somewhat conventional, bearing a close resemblance to Type VIII in Paul Kunitzsch, *Typen von Sternverzeichnissen in astronomischen Handschriften des zehnten bis vierzehnten Jahrhunderts* (Wiesbaden, 1966), pp. 51–8. Thirty-nine of the 43 stars in Westwyk's list appear among the 49 stars in Kunitzsch's Type VIII; for other examples, see Cambridge University Library, MSS Ii.3.3, fol. 70v, and Add. 6860, fols 70v–71r.

[86] North, *Chaucer's Universe*, p. 158.

[87] Its roots in Arabic are unclear. On its etymology and variant meanings, see Benjamin and Toomer, *Campanus of Novara*, pp. 374f. See also José Chabás, 'El Almanaque Perpetuo de Ferrand Martines (1391)', *Archives internationales d'histoire des sciences*, 46 (1996), 261–308. In the *Exafrenon* translation the word is spelt 'Armanac', not 'Almanac' as in Price's partial edition; Oxford, Bodleian Library, MS Digby 67, fol. 6ra; Price, *The Equatorie of the Planetis*, p. 204.

[88] Price, *The Equatorie of the Planetis*, p. 64.

[89] It is used for the prime meridian in a table of latitudes and longitudes in the instrument compilation Salamanca MS 2621, fol. 95v. See also Bodleian Library, MS Laud Misc 674, fol. 73r, which cites Arzachel on the difference in longitude between Arim and Toledo. Its location on the equator is asserted in the *De sphera* of Robert Grosseteste (*Moti, virtù e motori celesti nella cosmologia di Roberto Grossatesta: studio ed edizione dei trattati De sphera, De cometis, De motu supercelestium*, ed. Cecilia Panti (Florence, 2001), line 54, p. 292), as well as in some commentaries on Sacrobosco's *De sphera* (see *The Sphere of Sacrobosco and Its Commentators*, ed. Lynn Thorndike (Chicago, 1949), pp. 188, 333).

[90] See, for example, *The Astronomical Tables of Al-Khwārizmi: Translation with Commentaries of the Latin Version Edited by H. Suter, Supplemented by Corpus Christi College MS 283*, ed. O. Neugebauer, Hist. Filos. Skr. Dan. Vid. Selsk. 4, no. 2 (Copenhagen, 1962), pp. 11, 86, citing marginal note in Paris, Bibliothèque Mazarine, MS 3642.

[91] Rudolf of Bruges, *The Treatise on the Astrolabe*, ed. Richard Lorch, in *Between Demonstration and Imagination: Essays in the History of Science and Philosophy Presented to John D. North*, ed. Lodi Nauta and Arie Johan Vanderjagt (Leiden, 1999), pp. 55–100 (p. 75).

[92] I am not suggesting that John Westwyk read Rudolf's treatise, or that Rudolf's treatise is the treatise on the astrolabe referred to in the *Equatorie* (that would be extremely unlikely, as Rudolf does not use the phrase 'midnight line' or anything similar; he always refers to it as 'linea septentrionalis').

[93] Peterhouse 75.I, fol. 72r.

[94] 'Nota nomina extranea que reperiuntur in libris autorum.' Vienna, Österreichische Nationalbibliothek, Cod. 5438, fols 168r–171r. It is edited in Paul Kunitzsch, *Mittelalterliche astronomisch-astrologische Glossare mit arabischen Fachausdrücken*, Sitzungsberichte der Bayerischen Akademie der Wissenschaften, philosophisch-historische Klasse 5 (Munich, 1977).

[95] Cod. 5438, fol. 168r, in Kunitzsch, *Mittelalterliche astronomisch-astrologische Glossare*, p. 13.

[96] Peterhouse 75.I. *Lyne alhudda* appears (13 times) only on fols 72r–73r; *meridional lyne* (12 times) only on fols 77r–78v.

[97] Kunitzsch, *Mittelalterliche astronomisch-astrologische Glossare*, 23. Kunitzsch notes that

the usual Arabic equivalent to *linea medii celi* was *khaṭṭ wasaṭ as-samā'*. He suggested that the mystery word could also be read as *alruha* or *aliuha*, but was equally unable to identify them. It is also just conceivable that *Alhudda* is a transliteration of the Arabic *aḥuḍḍa* (meaning depths); the singular form *ḥaḍīḍ* referred to the perigee. But Westwyk's 'lyne alhudda' describes the radius of the equatorium on which lies the solar apogee, rather than its perigee.

[98] *Middle English Dictionary*, ed. McSparran.

[99] Wilson, 'Linguistic analysis'; Partridge, 'Vocabulary'.

[100] Partridge, 'Vocabulary', p. 31.

[101] Butcher, 'Textual production and vernacular behaviour', p. 296.

[102] On the relationship between language and register, see Peter Murray Jones, 'Language and register in English medieval surgery', in *Language in Medieval Britain: Networks and Exchanges*, ed. Mary Carruthers (Donington, 2015), pp. 74–89.

[103] Peterhouse 75.I, fol. 64^{r}, where Westwyk cites 'R.B.' as an authority for a table; Linda Ehrsam Voigts, 'The "Sloane Group": related scientific and medical manuscripts from the fifteenth century in the Sloane Collection', *British Library Journal*, 16 (1990), 26–57, examines use of the initials 'R.B.' in three related scientific manuscripts, and suggests that they most likely refer to Roger Bacon. Bacon was known to have drawn up astronomical tables; see *The Opus majus of Roger Bacon*, ed. John Henry Bridges (1897; reprinted Cambridge, 2010), pp. 208–10; Roger Bacon, *Compendium studii philosophiae*, in *Opera quaedam hactenus inedita*, ed. J. S. Brewer (London, 1859), I, 391–519 (p. 433).

[104] Pereira, 'Alchemy and the use of vernacular languages', p. 336.

[105] As already stated, Peterhouse 75.I and Aberdeen 123 certainly come from religious houses; the volvelle text in Ashmole 191 may be associated with the Cistercian abbey of Newminster (the relationship between the different parts of the manuscript is hard to reconstruct).

[106] This list has been compiled by comparing entries in the *Oxford English Dictionary* and *Middle English Dictionary*, drawing on the linguistic analysis by R. M. Wilson ('Linguistic analysis'). It must be considered provisional.

[107] See above, nn. 8 and 52, for discussion.

[108] Lignières, *Compositio equatorii*; Cambridge University Library, MS Gg.VI.3, fols 217^{v}–220^{v}, in Seb Falk, 'A Merton College equatorium: text, translation, commentary', *SCIAMVS*, 17 (2016), 121–59; Richard of Wallingford, *Tractatus albionis*; Campanus of Novara, *Theorica planetarum*. See also Guy Beaujouan, 'Le Vocabulaire scientifique du latin médiéval', in *La Lexicographie du latin médiéval et ses rapports avec les recherches actuelles sur la civilisation du Moyen Âge* (Paris, 1981), pp. 345–54. Reprinted in *Par raison de nombres: l'art du calcul et les savoirs scientifiques médiévaux* (Aldershot: 1991), VIII.

[109] Paul Kunitzsch 'Glossar der arabischen Fachausdrücke in der mittelalterlichen europäischen Astrolabliteratur', *Nachrichten der Akademie der Wissenschaften in Göttingen: philologisch-historische Klasse*, 11 (1982), 455–571; *Naṣīr al-Dīn al-Ṭūsī's Memoir on Astronomy (al-Tadhkira fi 'ilm al-hay'a)*, ed. F. Jamil Ragep (New York, 1993). I have transliterated the Arabic of Ragep's edition of Naṣīr ad-Dīn at-Ṭūsī's *Memoir on Astronomy*, and standardized Kunitzsch's transliterations.

[110] Rudolf of Bruges, *The Treatise on the Astrolabe*, p. 75.

[111] North, *Chaucer's Universe*, p. 188.